1 A Spectrum of Challenges

"Even in the largest and oldest national parks … most often the serious ecosystem stressors … are not so much from tourism and the interaction of park visitors with nature but represent forces operating at regional to global scales."

—Gary E. Davis, David M. Graber, and Steven A. Acker

The National Park Service is grappling with numerous regional and global environmental issues that affect the preservation and management of park natural resources. Topping this list are climate change and related rising sea level, coastal erosion, changes in local and regional precipitation, and flooding; air and water pollution; depletion of marine resources; introductions of nonnative diseases and organisms; and land-cover change. Understanding how park resources respond to these phenomena, whether those changes are within the range of normal variability, and when and how to intervene to prevent impairment of park resources, if it is even possible, is a key information need of the National Park Service today. By detecting change in the condition of park resources, resource monitoring is emerging as a critical tool for managers to use in filling this information gap. Other research is needed, too, to address this broad spectrum of challenges, as are effective policies and performance measures, consultation strategies, interagency cooperation, and enforcement of regulations. The articles that follow offer interesting glimpses into some of these complex, far-reaching environmental issues and the role that science, policy, legislation, leadership, and partnerships are playing in the understanding and management of these issues in the National Park System.

Water Resources Division tracks water quality impairments in parks

By Gary Rosenlieb, John Christiansen, Dean Tucker, and Mike Matz

MEASURING AND TRACKING HISTORICAL TRENDS in water quality has always been a daunting task for park managers. More daunting is the management of problems when they are discovered, because almost all park water quality problems are caused by external sources. Parks are faced with a wide array of pollutants emanating from sources typically outside park boundaries. Nutrient and metal-laden runoff from development, agriculture, and mining activities threatens many park aquatic systems with basic changes in chemical and biological structure. Pollution from atmospheric deposition of mercury is being biomagnified through the wetlands of the Everglades as well as in the many northeastern and midwestern parks.

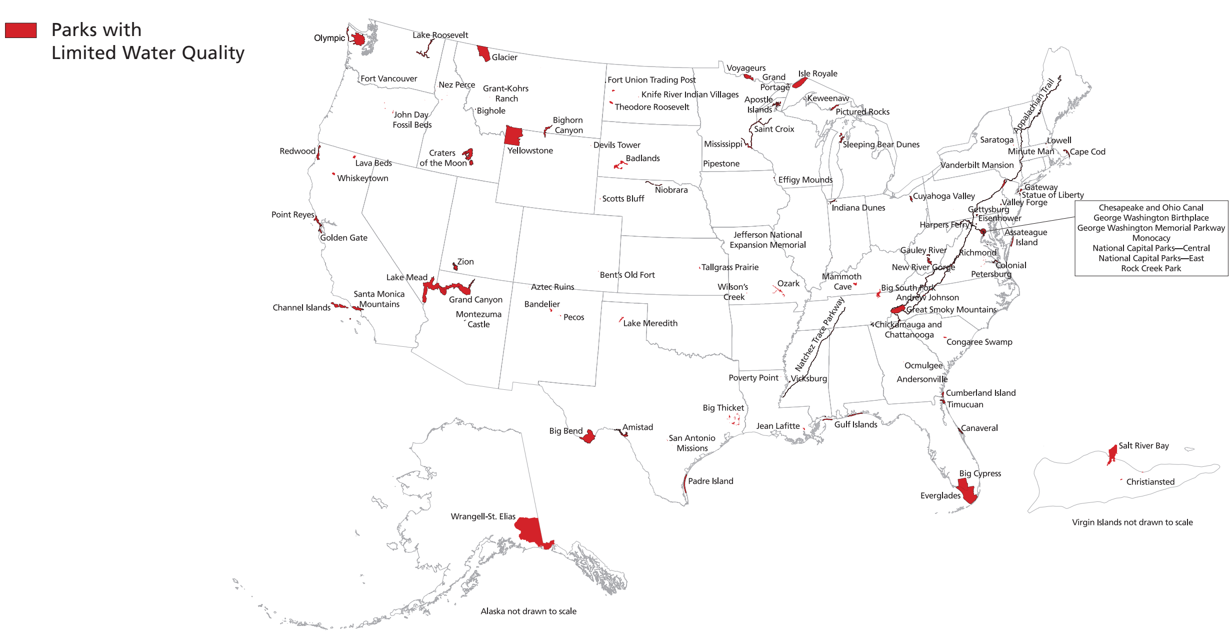
Though the ultimate solution to many of our water pollution problems may be many years in the future, two major program developments during the last five years, the Government Performance and Results Act and the Natural Resource Challenge, have enabled the National Park Service (NPS) to begin to assess the magnitude of water quality problems. Current goals established by the Department of the Interior (DOI) require that bureaus track and report on waters that are meeting Clean Water Act water quality standards. Through the Natural Resource Challenge, $3.1 million has been dedicated to water quality monitoring in parks to identify and monitor water quality problems and issues as resolutions of them are implemented.

To facilitate tracking and reporting for the DOI and NPS strategic plans the Water Resources Division has constructed a Service-wide database entitled "Waterbody Designated Uses and Impairments," which contains the results of park-specific inventories of surface-water hydrography and water quality impairments. The inventory is based on the U.S. Geological Survey 1:100,000 and 1:24,000 scale National Hydrography Dataset, a comprehensive set of digital spatial data representing surface water features. The Water Resources Division uses this framework to house the water quality impairment portion of the water resources inventory. Section 303(d) of the Clean Water Act is currently the criterion for defining water quality impairments in the inventory. This portion of the act requires states to publicly identify waters that do not meet water quality standards. Essentially, water is deemed to be in violation of water quality standards or "impaired" when any narrative or numeric criteria are exceeded or when designated uses are shown to be adversely affected by human activities. Common designated uses of water include recreation, aquatic life (including fisheries), public water supplies, and industrial and agricultural activities.

> *Nutrient and metal-laden runoff from development, agriculture, and mining activities threatens many park aquatic systems with basic changes in chemical and biological structure.*

Based on the estimates developed by the Water Resources Division, the National Park Service manages (within the boundaries of the 342 units currently tracked) about 138,000 miles (222,042 km) of rivers and streams, and about 5,000,000 acres (2,025,000 ha) of lakes, reservoirs, estuaries, and marine areas. Of these, 118 park units have one or more water bodies that do not meet state water quality

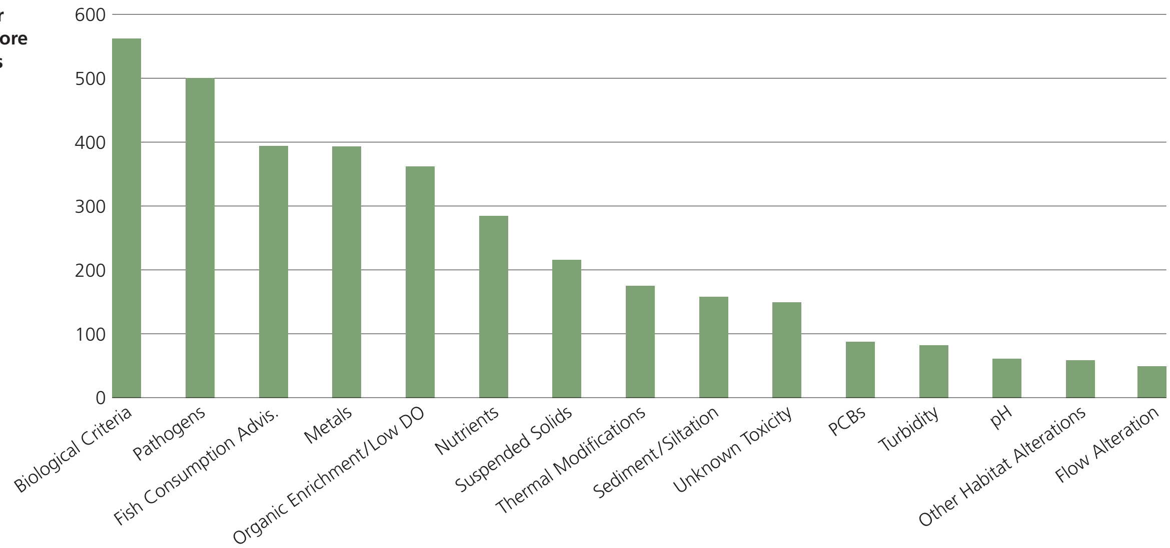
PARKS WITH WATER QUALITY EXCEEDANCES AND USE IMPAIRMENTS



Pollutants That Exceed Water Quality Standards in 50 or More Miles of NPS Managed Rivers

y-axis = Miles

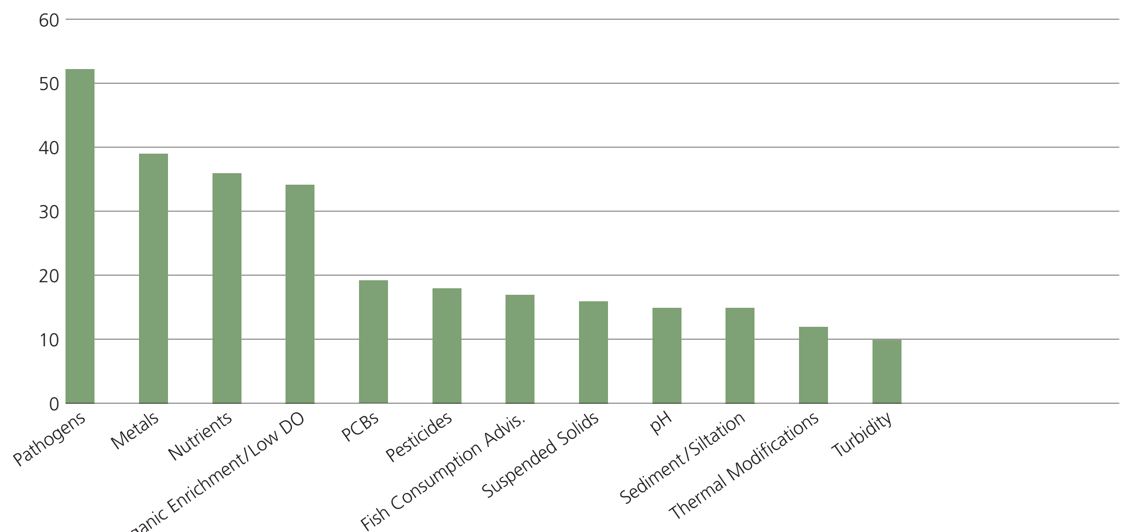
x-axis = Pollutant Category



Pollutants That Exceed Water Quality Standards in 10 or More Parks

y-axis = Number of Parks

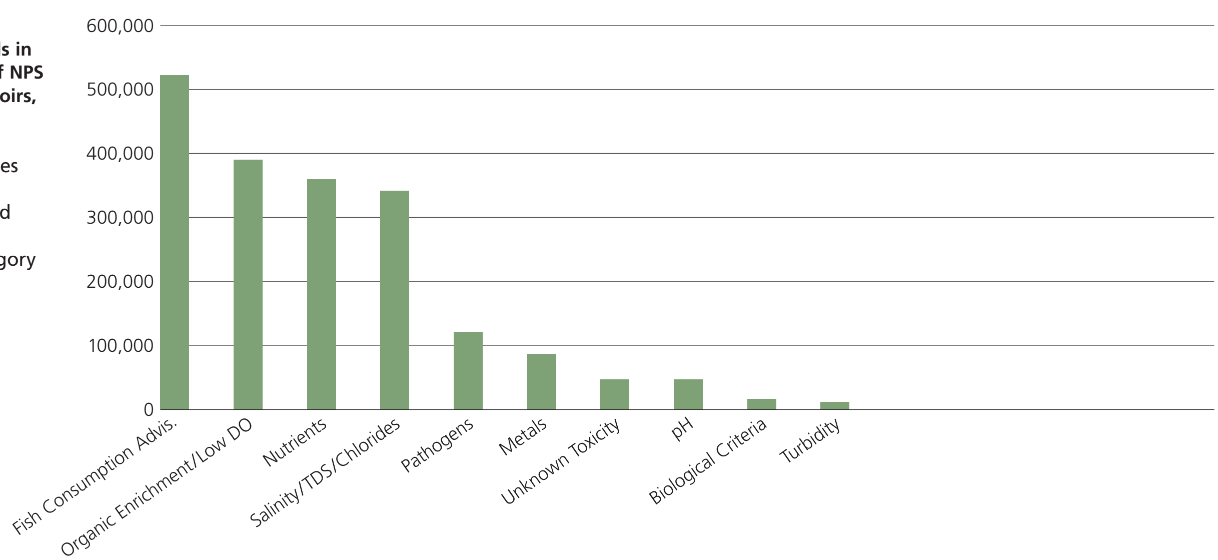
x-axis = Pollutant Category



Pollutants That Exceed Water Quality Standards in 10,000 or More Acres of NPS Managed Lakes, Reservoirs, and Marine Areas

y-axis = Number of Acres Where Water Quality Standards Are Exceeded

x-axis = Pollutant Category



standards for one or more pollutants, on about 1,600 miles (2,574 km) of rivers and streams and 1,114,000 acres (451,170 ha) of lakes, reservoirs, estuaries, and marine areas. Overall, 35 different pollutant groups have been identified that exceed standards and impair recreational and aquatic life uses of water. Fecal-indicator bacteria, the most common pollutant group, impair recreational uses in 52 parks. Metals, nutrients, low dissolved oxygen, polychlorinated biphenyl, and pollutants that primarily impact aquatic life affect the second greatest number of parks. From a hydrographic standpoint, the dominant water quality impairment is the failure to meet biological criteria in almost 560 miles (901 km) of rivers and streams, followed by bacteria, fish consumption advisories, and metals, respectively. In standing waters, fish consumption advisories prompted by organic and metal contamination on about 535,000 acres (216,675 ha) of lakes, reservoirs, estuaries, and marine areas are the dominant use impairment, followed by organic enrichments or low dissolved oxygen, nutrients, salinity, and chlorides, respectively.

Information in the water resources inventory is continually being updated. The Water Resources Division will also be designating the inventory for water quality standard state-designated uses and will begin to merge and use data collected through the Natural Resource Challenge Water Quality Monitoring Program for tracking attainment of the water quality goal. The database can be accessed at http://www1.nrinta.nps.gov/wrd/dui. ■

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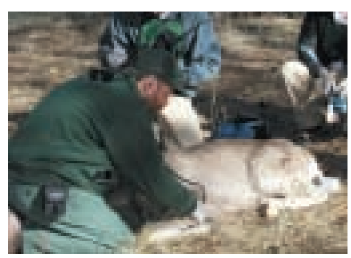
Expert team formed to assist parks with wildlife health issues

By Margaret A. Wild, DVM, Ph.D.

The past two decades have seen the worldwide emergence of numerous infectious diseases of wildlife, threatening biodiversity and conservation efforts. Public concern is further heightened when human health is endangered by the sharing of these diseases between wildlife and humans in cases such as West Nile virus, monkey pox, and avian flu. In many instances these diseases are non-native introductions, or their occurrence has been significantly influenced by people.

As a result, managers with the National Park Service are increasingly faced with addressing these emerging infectious disease issues. Because disease prevention and management actions can be complex, controversial, and time-consuming, and can require urgent implementation to minimize disease impacts or limit spread, response can be challenging. To help attend to this need, the NPS Biological Resource Management Division (BRMD) secured new funds to establish a Wildlife Health Team in FY 2004. The team, patterned after the highly successful Exotic Plant Management Teams, is designed for rapid-response assistance to the national parks. It is a component of the BRMD Wildlife Health Program, located in Fort Collins, Colorado, and consists of a wildlife veterinarian, wildlife biologist, veterinary technician, wildlife technician, and project manager to assist parks with environmental efforts on management plans for elk and deer that are affected by chronic wasting disease. The funding not only



Wildlife Health Team wildlife technician Scott Ratchford assists park staff by monitoring a mule deer anesthetized for tonsillar biopsy for chronic wasting disease and radio collaring at Rocky Mountain National Park.

pays for the team members and their travel to assist parks but also supports tactical management applications, diagnostic testing of biological samples, and environmental planning.

Because of the significant concern surrounding chronic wasting disease of deer and elk, the team initially will focus much of its field effort in Rocky Mountain National Park (Colorado) (see related article on page 79) and Wind Cave National Park (South Dakota) where the disease occurs. However, the team is available across the national park system for technical assistance and consultation. The range of diseases addressed and sites of team response will undoubtedly expand as parks identify new threats to wildlife resources. ■

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Colorado River basin drought

By Bill Jackson, Ph.D., and Greg Eckert, Ph.D.

THE MOST SEVERE DROUGHT ON RECORD, and possibly the most severe drought in the past 500 years, has persisted since 1999 in the intermountain West. Nowhere is the expression of drought in the Colorado River basin more dramatic than at Glen Canyon and Lake Mead National Recreation Areas. Lake Powell and Lake Mead have lost approximately half their storage, and reservoir surfaces have dropped more than 100 vertical feet (30 m). In 2004, Lake Mead was at its lowest level in 40 years. Although drought helps define ecosystem structure and function and favors the survival of certain species over others—much as hurricanes, floods, and wildfire do—it presents special challenges to National Park System managers. This is particularly true when park hydrology has been modified or habitat has been lost or degraded. The Colorado River basin drought offers perspectives on both the ecological influences of drought and related challenges for park managers.

Ironically, river regulation on the Colorado and Green Rivers has effectively denied the influence of natural drought on those systems because water deliveries downstream are maintained at unnaturally high levels by depleting reservoir storage. Raising the minimum flow during periods of drought may actually work against the survival of the river's native fish. For example, cold water that supports nonnative trout is thought to be related to decline of the endangered humpback chub (*Gila cypha*) in the Colorado River in Grand Canyon. (See the related article on page 52 for a discussion of conservation of native fish species in the upper Colorado River basin.) Conversely, the largely undammed tributaries to the Colorado River have experienced periods of extremely low flow during the current drought. Flows in the Yampa River in Dinosaur National Monument, for example, dropped as low as 3 cubic feet per second (0.08 m^3/s) in July 2002, compared with the mean monthly July flow of 1,549 cubic feet per second (44 m^3/s). Natural drought would possibly favor native species that are adapted to these conditions over their introduced competitors. Natural drought may also contribute to a decline in native species, especially where these species are already impaired because of compromised habitat and competition with nonnative species.

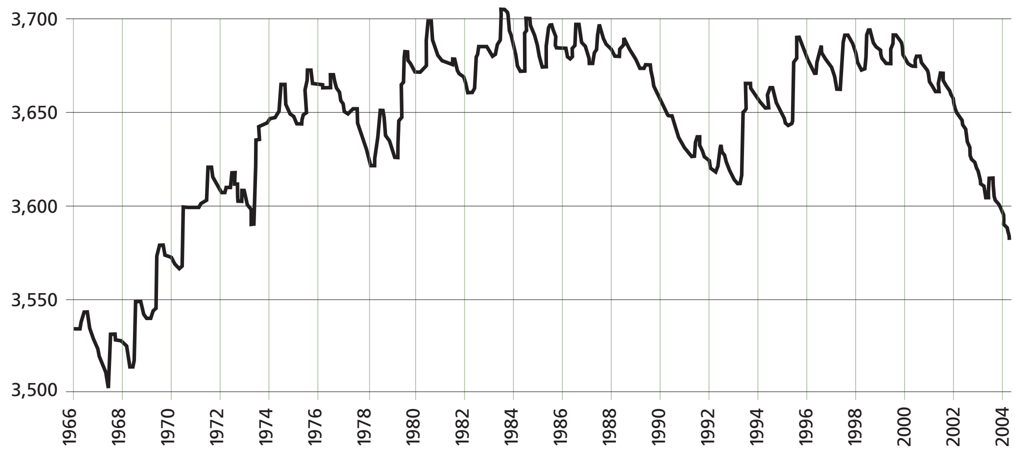
Springs in arid systems like the Colorado River basin are keystone habitats affected by drought. Springs and hanging gardens support a high level of biodiversity and many endemic and rare species. Animals that rely on spring-generated water or plants found only in hanging gardens may be stressed during periods of drought. Reduced spring flow during drought is a natural ecological process; however, the implications of drought-induced stress for species that are dependent on springs may be greater than under natural conditions; many springs in the region are already in decline because of groundwater pumping or overuse by introduced species or domestic livestock.

Though some ecosystems such as cold-desert shrub and spruce-

White sandstone cliffs reveal the high-water mark of Lake Powell, more than 100 feet above the lake's elevation at the end of 2004. The "bathtub ring" is symbolic of a severe drought that has park managers in the Colorado River basin contemplating the implications of the dry period on park resources.

LAKE POWELL WATER SURFACE ELEVATIONS, 1966 TO 2004

The graph shows a series of fluctuations in the level of Lake Powell, Glen Canyon National Recreation Area. In 1983, approximately 20 years after construction of the Glen Canyon Dam, the lake filled. In 2004, its levels were the lowest since the initial filling period in the early 1970s.



fir forest were primed for infrequent, climate-driven, stand-replacing fires that characterize their fire regime, other forest and woodland systems that historically experienced frequent but low-severity fires were not prepared for drought conditions. Because of past management practices that excluded fire, these woodland systems were already vulnerable to unnaturally high-severity wildfire. Drought further increased the risk of these systems to high-severity fire and reduced the effectiveness of recent treatments to decrease fuel buildup in slowing some fires.

Another drought-related phenomenon is the massive dieback of pine trees as a result of the spread of piñon Ips beetle (*Ips confusus*). Numerous trees became established and existing trees grew larger during the 20-year wet period leading up to the present drought. This resulted in more biomass than could be supported during average climatic conditions. In the mid-1990s when the climate plunged into a severe drought and higher temperatures favored insect populations, trees were left more vulnerable to moisture stress and insect attack than they would have been had the previous two decades brought lower, more normal amounts of precipitation.

Both aquatic and terrestrial species' responses to drought must be viewed in the context of long-term success of populations, in addition to the more obvious short-term responses of individuals—that many individuals are now dying from drought. Mobile animals will fare better than plants or species with limited range or ability to disperse. Rare species may have insufficient numbers of drought-resistant individuals to regenerate populations once suitable conditions return.

How should the National Park Service respond to drought? Policies incorporate natural processes such as drought as part of the systems and resources being managed. Yet barriers to recovery now present themselves as causes for providing active assistance to resources during and after a drought. These barriers include effects of fire exclusion, urban expansion, river regulation and water development, and alien species. Increased understanding of the historical range of variability of resources will help managers understand system dynamics and the need for intervention. Park managers must carefully describe what manipulations will be required to achieve desired future conditions of park resources, including maintenance and recovery of unique resources that are the key to diversity across the vast Colorado River basin. They must also identify the range and condition of critical habitats, such as springs and hanging gardens, and develop landscape-scale plans for preservation until research and resource monitoring clearly indicate that detrimental human-induced changes can be rectified to sustain these resources during times of drought. ■

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Monitoring climate change in central Alaska

By Pamela Sousanes

RECORDS SHOW THAT ALASKA WARMED SUBSTANTIALLY over the 20th century, particularly over the past few decades (Overpeck et al. 1997). Since the 1950s, average warming has been 4°F (2°C) across the state. The greatest warming, about 7°F (4°C), has occurred in the state's interior in winter (Chapman and Walsh 1993; Weller et al. 1998). The growing season has lengthened by more than 14 days since the 1950s (Keyser et al. 2000). In 2004, Denali National Park and Preserve headquarters recorded the warmest mean monthly temperatures for May, June, and August based on an 80-year National Weather Service record. How will a continued increase in temperature affect subarctic park ecosystems? Melting permafrost, increased fire activity, receding glaciers, treeline migration, wildlife migration pattern changes, and ozone depletion are all realized effects of climate change in interior Alaska.

The Central Alaska Network is part of the NPS Inventory and Monitoring Program, funded through the Natural Resource Challenge. The primary goal is to build a holistic picture of network ecosystem conditions by detecting change in a variety of ecological components and in the relationships among those components. The three park units of the Central Alaska Network—Denali National Park and Preserve, Wrangell–St. Elias National Park and Preserve, and Yukon-Charley Rivers National Preserve—cover 21.7 million acres (8.8 million ha) and encompass 12 of the 32 distinct ecosystems in Alaska (Nowacki et al. 2002). Elevations range from sea level to 20,320 feet (6,194 m). Latitudes span from 55 degrees north to more than 65 degrees north. Climate in this vast area is extremely variable, ranging from strongly maritime to strongly continental, with large differences in temperature and precipitation. These climate gradients are intrinsic to the ecosystem patterns and ecological communities found in Central Alaska Network parks.

One of the most important outcomes of the winter climate of the subarctic is the creation of snow cover. This variable snow cover protects and insulates the ground and low-lying plants, reduces desiccation, and maintains ground temperatures that are generally higher than air temperatures. Accordingly, climate and snow pack have been identified by the Central Alaska Network as important vital signs (MacCluskie and Oakley 2003).

Melting permafrost, increased fire activity, receding glaciers, treeline migration, wildlife migration pattern changes, and ozone depletion are all realized effects of climate change in interior Alaska.

One of the main objectives of the Central Alaska Network is to monitor and record weather conditions at representative locations in order to identify long- and short-term trends, provide reliable climate data to researchers, and participate in larger-scale climate monitoring and modeling efforts. In an attempt to better understand climate variations, new long-term climate monitoring stations are being installed throughout the three parks. Building upon the Long-term Ecological Monitoring Program initiated at Denali in 1992, compatible research-grade climate monitoring equipment was tested. In 2003–2004 more than 30 sites were visited at the three parks to obtain specific information on the suitability of each site for climate monitoring. A panel of climate experts from the National Weather Service, the Natural Resources Conservation Service, and the Western Regional Climate Center was solicited to review a detailed, technical site evaluation completed in the winter of 2004. Through

Staff of the Central Alaska Network tested 10 climate stations at Denali National Park and Preserve headquarters in 2004 as part of a coordinated program of resource monitoring to understand trends in climate change in the park. Testing allowed resource managers to identify and correct inherent bugs in programming, instrumentation, and power systems before installing the systems in remote park locations.

This weather station was installed in Wrangell–St. Elias National Park and Preserve in 2004 at an elevation of 4,554 feet (1,389 m) above sea level. The location was prioritized as a high-elevation site in the park following a comprehensive evaluation of more than 50 locations in three national parks monitored by the Central Alaska Network.

this review, the National Park Service formed partnerships with each of these agencies, culminating in interagency agreements and Cooperative Ecosystem Studies Unit agreements that will offer longevity for the program by providing a means for data archiving and general support and technical assistance from regional climatologists. The design development phase initiated in 2004 included the placement of stations at remote locations. The near-real-time data generated by these stations will be used in unlimited ways to incorporate local climate variations with individual research projects and other network monitoring components, and to inform visitors and park managers about current conditions. ■

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Landscape dynamics in the Northeast Temperate Network: Thirty years of change

By W. Gregory Shriver, Gregory Bonynge, and Y. Q. Wang

ONE OF THE MOST PROFOUND EFFECTS of humans on the landscape is alteration of habitats critical to plants and animals. As people construct roads and build houses, they convert once-continuous habitats into areas of non-habitat and fragment large areas of habitat into patches that are too small to support native species. In the Northeast, most ecosystems have experienced loss and fragmentation of habitat, and these changes are a principal threat to native biodiversity. National parks are limited in size and many species require critical seasonal habitat that exists or genetic interchange that occurs outside park boundaries. Changes in land use near a park can influence actions to manage invasive species or maintain water quality. Therefore, park managers need information about changes to the landscape both inside and outside parks to effectively conserve a park's native flora and fauna.

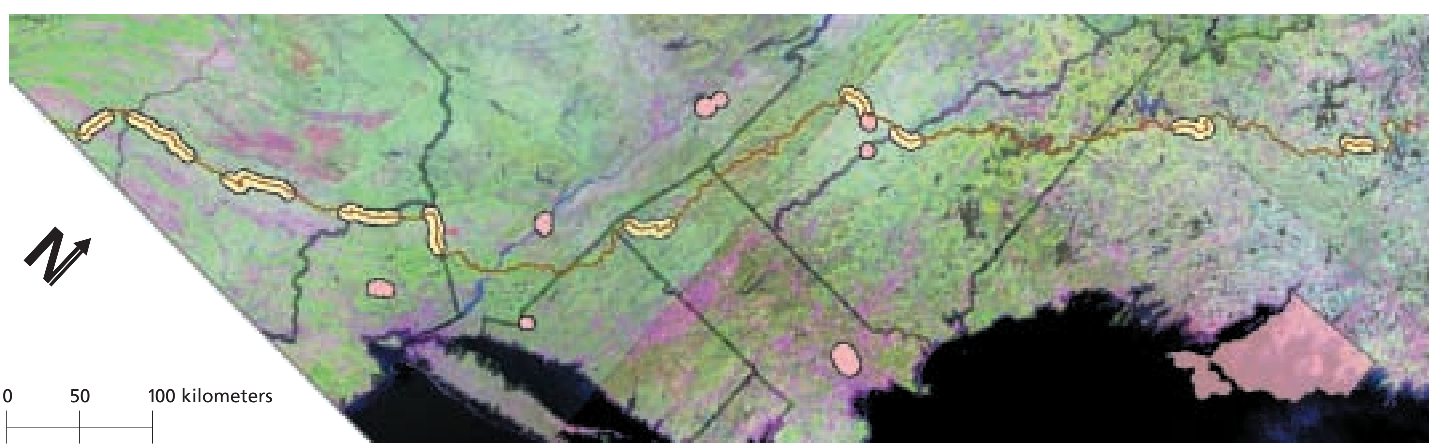
The Northeast Temperate Network (NETN) monitors the condition of resources in 10 national park units in seven northeastern states. Because the network cannot monitor all resources, a subset of information-rich "vital signs" is selected that includes physical, chemical, and biological elements, and indicates the overall condition of park natural resources. Many networks in the I&M Program have identified landscape dynamics as a high-priority vital sign because change adjacent to parks can alter water quality and flow regimes, increase invasive plant and animal introductions, reduce contiguous forest, and influence ambient sounds and clear night skies, among other impacts. For example, feral cats, which prey on native birds, amphibians, and small mammals, are now common in many northeastern parks. To address such issues, the network initiated a project in 2003 using remote sensing data to determine the present land cover and estimate land-cover changes since the early 1970s.

The first step in developing a land-cover change monitoring program is to characterize the existing landscape within and around each park and, if possible, determine how the extent of ecosystems has changed over time. Many types of remote sensing data could be used to determine changes in land cover and provide a consistent, repeatable sampling methodology to monitor change. Project investigators selected the Landsat series of satellite data because it provides a 30-year history from the early 1970s with nearly continuous coverage to the present time. Eight park units and 10 Appalachian National Scenic Trail segments are included in the project, effectively creating a retrospective assessment of land-cover change at 18 sites in the Northeast (see map).

> *Landscape … change adjacent to parks can alter water quality and flow regimes, increase invasive plant and animal introductions, reduce contiguous forest, and influence ambient sounds and clear night skies, among other impacts.*

The land-cover change assessment at each site includes within-park changes and changes within a 3-mile (5-km) buffer around each park. For example, preliminary results for Minute Man National

LAND-COVER STUDY AREAS IN THE NORTHEAST TEMPERATE NETWORK



The Northeast Temperate Network (NETN) has undertaken a project to determine current land cover and estimate its changes since 1970. The project will study areas adjacent to eight units monitored by the NETN (shown in pink) and 10 sites along the Appalachian National Scenic Trail (shown in yellow), where the project will be coordinated with five local monitoring networks. Information from this project will have broad applicability, not just to the National Park Service but also to local land planners.

Historical Park in Concord, Massachusetts, indicate that within a 3-mile (5-km) radius of the park, urban land cover has increased 50% since 1978, while wetland and forest cover have declined by 68% and 8%, respectively. Analysis within these buffer zones provides information for resource managers to quantify land-cover changes adjacent to the parks over the past 30 years and can help in setting priorities for monitoring and restoration. Knowing that old field habitat in the landscape around the park has been converted to residential development increases the importance of these habitats in the park and gives park managers the information they need to make management decisions.

In August 2003 and June 2004, the University of Rhode Island (URI) team undertaking the project visited each of the 18 study sites to meet with NPS and Appalachian Trail Conference (ATC) natural resource managers and volunteers. During these meetings the team reviewed the satellite images and learned about the unique characteristics of each study site. In partnership with these NPS and ATC representatives, the URI team acquired an extensive library of more than 2,800 geo-referenced digital photographs. These photographs permit cross-checking the land-cover data with the Landsat scenes and offer a reference that could be used for the long-term monitoring of land-cover change around the parks.

A final step in this project will provide a "gap analysis," which will assess the extent of land-cover types on conservation lands (lands that cannot be developed) around each park and trail segment. The analysis will determine whether, for example, any ecosystems are missing or rare, and thus how well these areas adjacent to parks protect priority ecological systems. Information from this project will therefore be applicable to a wide audience, including park personnel, ATC volunteers, other networks, and local land planners. ■

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National Park Service joins the U.S. Animal Health Association

By Glenn Plumb, Ph.D., and Margaret Wild, DVM, Ph.D.

The National Park Service recently gained agency membership in and a seat on the board of directors of the United States Animal Health Association (USAHA). The USAHA is a science-based, nonprofit, voluntary organization that has served as the nation's animal health forum for more than a century. Its mission is to protect animal and public health by facilitating communication about and coordination of animal disease management and eradication, serving as a clearinghouse for new information and methods for policy and program development, and finding solutions for animal health issues. Although the organization has traditionally focused on livestock interests, the increase in livestock-wildlife disease interaction has recently spurred the inclusion of wildlife health interests as well. Since the National Park Service joined the association in 2003, the USGS National Wildlife Health Center and U.S. Fish and Wildlife Service have also become members.

Department of the Interior involvement has already led to important cooperative efforts. The USAHA president recently appointed a special committee on brucellosis in the greater Yellowstone area. Its purpose is to plan a symposium that will bring together key individuals from multiple federal, state, academic, and private sectors in 2005 to formulate a strategic plan to enhance brucellosis vaccines, vaccine delivery, and surveillance diagnostics for bison and elk in the greater Yellowstone area. The plan will describe the framework and level of agency support required to develop and test safe and effective bison and elk vaccines and methods for their delivery and to improve live-animal diagnostic capabilities in distinguishing infected animals from those only exposed to the disease. Membership in USAHA is expected to render additional similar opportunities to develop new partnerships that address important animal health issues throughout the National Park System. ■

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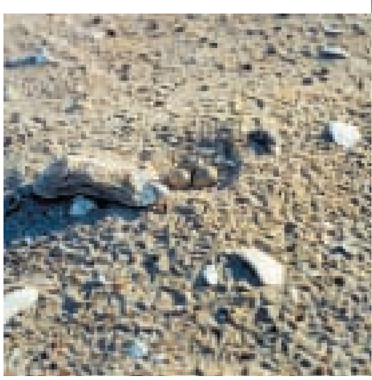
Ecosystem restoration in an altered coastal environment

By Courtney Schupp

OVERWASH IS A NATURAL AND NECESSARY COMPONENT of barrier island dynamics at Assateague Island National Seashore in Maryland and Virginia. Over long time scales, overwash processes will enable the island to respond to sea-level rise. On shorter, multiyear time scales, overwash processes deposit sand and cause landform changes, both of which are needed to maintain a healthy ecosystem for coastal plant and animal species. However, the Ocean City Inlet jetty, which was built in 1934 and periodically has been extended, has caused deficiencies in sediment supplies by blocking southward sand transport. When major storms in 1998 threatened to breach the island, the U.S. Army Corps of Engineers constructed a berm at the north end of the island to reduce the immediate breaching threat, and park managers developed a long-term plan to mitigate jetty-induced changes. The Corps of Engineers modeled the berm to be low enough to allow overwash processes but high enough to reduce the risk of island breaching.

Ultimately, however, models did not accurately predict the geomorphic and ecologic responses, and engineers developed the berm to such a height that it is impenetrable to both breaching and overwash. Furthermore, topographic surveys show that the berm is expanding seaward. The lack of overwash has reduced the number of mid-island depressions, which are a preferred foraging area for the piping plover (*Charadrius melodus*), a threatened migratory bird. As a result, the birds must find the majority of their food in the less productive intertidal areas along the bay and beach, an activity further complicated by an increase in vegetation along the lee side of the constructed berm. The section of the island that includes the constructed berm comprises only 28% of the undeveloped north end; however, it has disproportionately experienced 40% of the reduction in sparsely vegetated habitat. The increase in vegetation has impeded the plovers' access to the beach and bay, leading to fierce competition over the remaining access paths and sometimes resulting in starvation. In addition, a berm-induced decrease in overwash wrack and shell beds has forced plovers to change their nesting behavior, which typically shows a preference for coarse sand and pebbles that offer

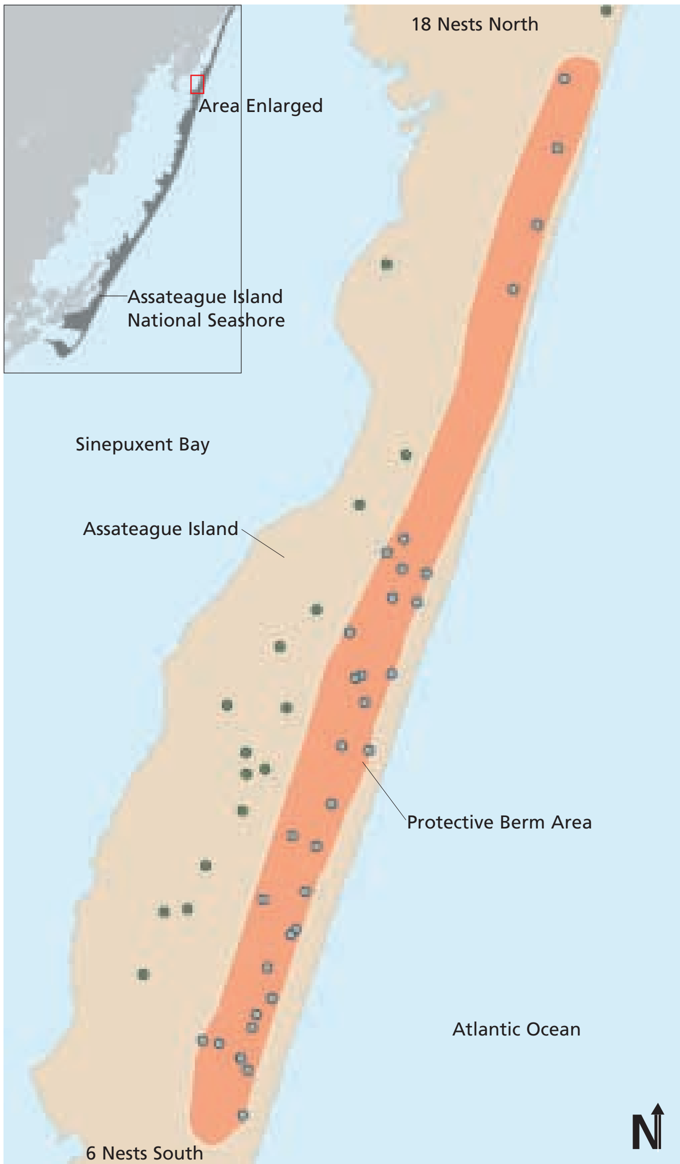
Assateague Island … and the U.S. Army Corps of Engineers are working together to address the unintended consequences of the berm to island ecology, and ultimately to restore natural ecologic and geomorphic processes to the ecosystem.



A berm constructed to reduce the potential for island breaching has prevented natural overwash processes and has reduced habitat availability for piping plover. The overwash (foreground) is funneling toward the bay through a low area at the southern tip of the berm. Modification of the berm to allow some overwash during storms will stimulate habitat and ecosystem restoration.

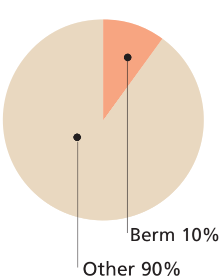
Shell beds deposited by overwash offer camouflage for piping plover nests.

PIPING PLOVER NESTS IN RELATION TO PROTECTIVE BERM, 2004

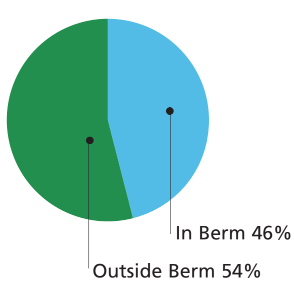


Location ● In Berm area ● Outside Berm area

Piping Plover Habitat



Piping Plover Nest Locations (2004)



Piping plovers have changed their nesting behavior in response to the constructed berm. The small berm area holds a disproportionately high percentage of the nests on the north end of the island because it offers camouflage for eggs, but it also fosters vegetation growth that reduces access to feeding areas and leads to competition and starvation.

camouflage for their eggs. Although the berm represents only 10% of the plover habitat available on the north end, it hosted 46% of the nests; the elevated concentration of birds in an area with reduced feeding access further increases competition and starvation.

Assateague Island National Seashore and the U.S. Army Corps of Engineers are working together to address the unintended consequences of the berm to island ecology, and ultimately to restore natural ecologic and geomorphic processes to the ecosystem. In January 2005, park staff will modify the berm by creating notches to allow occasional overwash into the island's interior. These lowered sections, which will comprise 10% of the berm's 1.2-mile (2-km) length, will simulate the average elevation of the natural storm berm, as measured in areas with reduced jetty impacts. Managers expect that during severe storm events, when overwash occurs in other sections of the island, overwash also will be able to penetrate the constructed berm through the lower notches. In order to analyze topographic changes, determine the success of the modifications, and advance scientific understanding of overwash processes, staff will survey the notched areas periodically and in the event of overwash penetration.

Integration of monitoring data with resource management activities triggered a reevaluation of the engineering models used to plan the construction of a protective berm, engendered a stronger interagency partnership, improved testing of models, and inspired modification of the berm structure. The partnership between the National Park Service and the Corps of Engineers will continue in order to manage park resources successfully and advance predictive modeling capabilities through the integration of science, engineering, and island observation and monitoring. ■

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Report has important implications for NPS management of ocean park resources

By Cliff McCreedy

ON 20 SEPTEMBER 2004 another government commission produced a voluminous report, but instead of disappearing into a file, the U.S. Commission on Ocean Policy's (U.S. COP) final report, *An Ocean Blueprint for the 21st Century*, splashed onto the front pages of newspapers around the country. The headlines read "Troubled Waters" (*St. Petersburg Times*) and "Panel Presses New Ocean Safeguards" (*Los Angeles Times*). The message of the commission was ominous and clear: "Pollution, depletion of fish and other living marine resources, habitat destruction and degradation, and the introduction of invasive nonnative species are just some of the ways that people harm the oceans, with serious consequences for the entire planet."

Mandated by the Oceans Act of 2000, the commission was appointed by President Bush and the Congress to review our nation's ocean stewardship. The first such review in more than 30 years, the U.S. COP report calls for basing ocean policy in a better scientific understanding of ecosystems, reforming fisheries management, doubling the nation's investment in ocean research, strengthening the National Oceanic and Atmospheric Administration (NOAA), and establishing regional ocean councils to coordinate among various levels of government and agencies.

The National Park System conserves a large portion of the nation's ocean and Great Lakes heritage, managing more than 3 million acres (1.2 million ha) of marine waters and 5,000 miles (8,045 km) of coast, including coral reefs, kelp forests, barrier islands, wetlands, and historic shipwrecks. Several of the report's recommendations have important implications for NPS management of threats to ocean park resources. With this in mind, the author served on several working groups coordinated by the White House Council on Environmental Quality (CEQ) to develop the Bush administration's response to the report.

On 20 December President Bush signed an executive order establishing an interagency oceans committee, and the CEQ released the U.S. Ocean Action Plan, the Bush administration's initial response to the U.S. COP report recommendations. The action plan adopts a new ocean resource management and protection strategy developed by the National Park Service and highlights its importance in meeting the goals of the commission report. In development since 2002, the NPS Ocean Park Stewardship Strategy identifies 28 action items under four major themes to protect and restore ocean park resources. The Park Service will formally launch the strategy in 2005, and a task force of park superintendents and NPS staff, led by Chief Ocean Scientist Gary Davis, will work to implement it.

The ocean commission's emphasis on the value of interagency coordination is a position shared by the National Park Service, which currently coordinates many of its management activities with NOAA, the U.S. Geological Survey (USGS), and university partners, and seeks to increase these programs. Recognizing that national parks and national marine sanctuaries are united by their proximity and resource management concerns, the Park Service and NOAA's National Marine Sanctuary Program signed a general agreement in 2000 to foster collaboration. To strengthen these partnerships, the Park Service proposed a "Seamless Network of Ocean Parks, National Wildlife Refuges, and Marine Sanctuaries" initiative. The CEQ also included this proposal in the U.S. Ocean Action Plan, adding the NOAA National Estuarine Research Reserves system. The Park Service, NOAA, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and university partners will develop national and site-level partnerships on research, habitat mapping, monitoring, education, enforcement, and evaluation of significant threats, including pollution, overfishing, and invasive species.

Congress has held hearings on the report and will consider its legislative and budget recommendations in 2005. *An Ocean Blueprint for the 21st Century* is a call to the National Park Service and the nation to enhance the scientific and organizational capacity to conserve our oceans. As the report suggests, much work lies ahead for the Park Service and its partners to conserve ocean resources, and the guidance of the U.S. COP report will inform many of these efforts. ■

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Poor land management practices and urban development can increase land erosion, leading to large sediment plumes (above) in coastal waters, just one of many types of ocean resource stewardship concerns in national parks. If sufficient sediment settles on nearshore coral reefs, it will smother individual corals (below, left), destroying the foundation of an ecosystem with species diversity comparable to tropical rainforests. National Park Service biological technician Ian Lundgren (below, right) collects sampling equipment at War in the Pacific National Historical Park, Guam, where natural resources staff is measuring sedimentation rates to assess impacts on the park's coral reefs and to monitor the effectiveness of erosion mitigation projects.

Cape Hatteras National Seashore develops beach nourishment guidance

By Julia Brunner and Rebecca Beavers

Rising sea level and hurricanes continually reshape the Outer Banks of North Carolina, including Cape Hatteras National Seashore, causing high rates of erosion. One approach for forestalling damage to infrastructure is to nourish beaches, a process that involves dredging sand and placing it on beaches to temporarily mitigate physical forces that cause erosion, wave damage, and flooding. National Park Service policy generally discourages beach nourishment (except in specific circumstances) because interference with natural geologic processes often causes unforeseen and detrimental impacts to coastal ecosystems.

Interference with natural geologic processes often causes unforeseen and detrimental impacts to coastal ecosystems.

For years, Cape Hatteras National Seashore—along with other locations on the Outer Banks—has been the site of repeated efforts to protect state and private infrastructure, including prevention or removal of overwash, construction of berms, and filling of breaches. Such actions may accelerate narrowing of the Outer Banks and their eventual disappearance. By contrast, natural processes such as overwash, inlet formation and movement, and shoreline migration preserve a barrier island's elevation above the rising sea. Because of ongoing human interference with natural processes, the Outer Banks' interiors are lower relative to rising sea level. Roanoke and Pamlico Sound marshes are eroding at an average rate of 2 feet per year (0.7 m/yr), and Atlantic Ocean beach erosion exceeds 7 feet per year (2 m/yr). If sea level continues to rise at its current rate and present storm patterns continue, the sediment-poor segments of the Outer Banks will "collapse," or drown in place, within a few decades.

To give park managers comprehensive information to evaluate beach nourishment proposals, a multidisciplinary team of planners, geologists, policy and regulatory specialists, and attorneys from the park, NPS Southeast Region, Regional Solicitor's Office, and Washington Office met at Cape Hatteras in early 2004. Throughout the year, the team developed a set of guidelines for park managers, other agencies, and the public to use in discussions and evaluations of beach nourishment projects. The draft guidance, still under review, describes the importance of natural barrier island processes, why the National Park Service generally discourages interference with these processes, and the formal procedure that park managers would use when considering requests for beach nourishment, pending the park's development of a comprehensive shoreline management plan.

Using the draft guidance document and ultimately the shoreline management plan, park managers can inform the public—including 2.5 million annual visitors to Cape Hatteras—and agencies that beach nourishment is not a substitute for natural barrier island processes. With increased recognition that beach nourishment has environmental and other consequences, this outreach effort may help preserve and protect dynamic barrier island processes along the Outer Banks. ■

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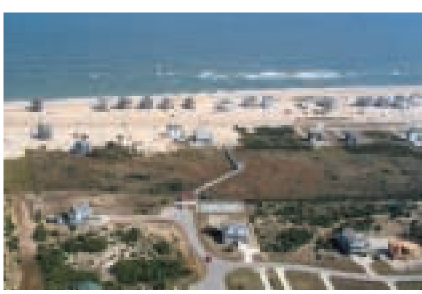

The owners of threatened homes and businesses in the seven oceanfront villages situated at Cape Hatteras National Seashore (left) may request beach nourishment to buffer their property from the ocean's erosive forces. Beach nourishment often involves dredging sand offshore, pumping it to the shore in a pipeline, and shaping the sand into a beach with bulldozers and other heavy equipment (below). Nourished beaches usually require periodic maintenance (renourishment). Cumulative, long-term impacts to offshore sand-mining areas and plant and animal communities on artificial beaches have not been well documented.

Sea-level rise impacts coastal parks

By Rebecca Beavers

Sea-level rise is an aspect of climate change that has profound implications for some coastal parks. In areas where beaches and wetlands migrate inland to survive elevated sea levels and increased storm surges, land managers must consider protection or retreat strategies for vulnerable coastal resources. For example, impacts from Hurricane Ivan in September 2004 on sections of Gulf Islands National Seashore in Florida illustrate how storms dramatically change coastal areas and overwash low-lying barrier islands. The destruction of most paved roads in the park near the Gulf of Mexico, particularly areas of Santa Rosa Island that breached from the gulf to the sound side, demonstrates how areas most vulnerable to sea-level rise will likely be most heavily altered by storms. These changes can lead to impaired natural resource conditions, reduced recreational opportunities, and threats to cultural and historical resources and park infrastructure. The direct impacts of sea-level rise include loss of beaches and beach properties, loss of ecologically productive wetlands, and loss of barrier islands that help shield the mainland from the impacts of storm surge. Indirect impacts include decreased revenues from tourism, reduced property values, and increased costs for repairing infrastructure such as roads.

A multiyear cooperative project between the National Park Service and the U.S. Geological Survey (USGS) assessed the spatial distribution of specific risks from sea-level rise (e.g., erosion, shoreline retreat, and inundation) and produced park-specific vulnerability maps and GIS data layers. In 2004, the USGS developed the Coastal Vulnerability Index for shoreline units at seven national parks, including Gateway National Recreation Area in New York and New Jersey, three island parks in the Pacific Ocean, and three parks in California. Investigators used information on coastal geomorphology, shoreline erosion rates, sea-level rise rates, storm surge, wave height, tidal range, and regional coastal slope to develop the index. These maps provide a relative index of park areas most likely to change as a result of sea-level rise. For example, the maps show park managers where new infrastructure should not be located. The maps also indicate the most vulnerable areas where managers may need to develop and implement relocation or retreat strategies in order to protect existing natural and cultural resources.

The USGS published open file reports for Assateague Island, Cumberland Island, Padre Island, and Cape Hatteras National Seashores in 2004. These reports and accompanying GIS data provide quantitative tools for park managers to use in long-term resource management planning, park facilities planning such as relocating buildings and roads, and assessing long-term threats to resources. The project Web page can be viewed at http://woodshole.er.usgs.gov/project-pages/nps-cvi/. ■

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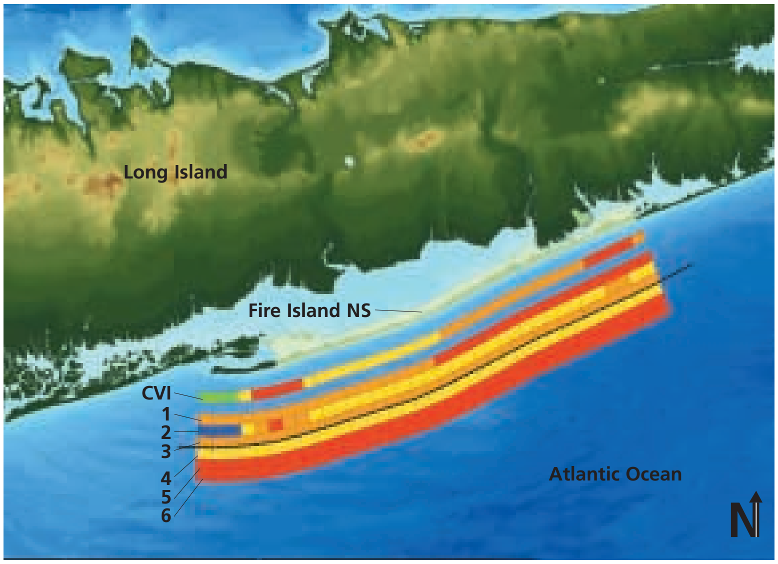
FIRE ISLAND NATIONAL SEASHORE RELATIVE COASTAL VULNERABILITY

Maps like this one of Fire Island National Seashore, New York, are products of the project and indicate relative coastal vulnerability, as shown by the colored bars. The inner color bar (CVI) is the overall coastal vulnerability index; the remaining bars (1–3) indicate the susceptibility of change to geologic processes and (4–6) physical process variables.

Vulnerability Ranking

Very High
High
Moderate
Low
Very Low



Photographic monitoring of glaciers in national parks

By Hal Pranger, Ron Karpilo, Bruce Molnia, and Hassan Basagic

INVESTIGATORS ARE PHOTOGRAPHICALLY CAPTURING glacier changes at Glacier Bay, Denali, Yosemite, and Sequoia and Kings Canyon National Parks. This joint project between the National Park Service and the U.S. Geological Survey demonstrates the value of using repeat photography to monitor glaciers. Investigators gathered more than 1,000 old photographs of glaciers and have located about 150 of the photo points in the field as of 2004. They photographed the glaciers from these photo points and compared the historical and modern images. Approximately 120 historical photographs in Glacier Bay, 25 in Denali, and 16 in Yosemite, Sequoia, and Kings Canyon have been repeated. Nearly all the glaciers in Denali, Yosemite, Sequoia, Kings Canyon, and Glacier Bay have been retreating rather dramatically in the past century. However, at least four glaciers at Glacier Bay have advanced or remained largely stable in the last half century, indicating that regional or even very local climatic changes related to the extremely high coastal Fairweather Mountains might be controlling the growth and decay of these particular glaciers.

The comparative photographs from Glacier Bay illustrate tremendous landscape, geomorphic, and floral changes. Investigators estimate that approximately 0.3 cubic mile (1.3 km^3) of sediment has filled the upper Carroll Inlet—that is, the area went from a several-hundred-foot-deep fjord to a glacial outwash plain high above sea level. Tremendous changes in vegetation accompanied this landscape shift, with vegetation encroaching immediately into the bare ground left by the retreating ice. Additionally, a complete transformation of upper Muir Inlet has occurred in the past 60 years, including the loss of about 0.6 mile (1 km) of ice thickness, several miles of ice length, and approximately 1.8 miles (3 km) of ice width since 1941. And since about 1750, approximately 600 cubic miles (2,500 km^3) of ice has melted from the whole of Glacier Bay.

An outcome of the monitoring has been public education and interpretation. Because investigators took photographs at a high resolution, they have been able to prepare large (10-foot- [3-m-] long) before-and-after panoramas for display in visitor centers. In addition, by using basic software technology, they have produced preliminary "pseudo-animated," retreating images of glaciers at Glacier Bay National Park, which are available at http://www2.nature.nps.gov/geology/GLBA/glaciers.htm. ■

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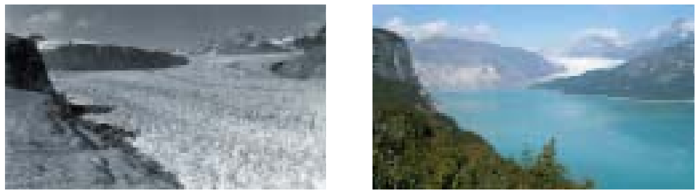

Stark changes in glacial mass are evident in Muir Glacier in the east arm of Glacier Bay. It has retreated approximately 12 miles (20 km) between 1941 (top left) and 2004 (top right), or approximately 28 miles (45 km) total since 1899.

Carroll Glacier in Queen Inlet in the west arm of Glacier Bay has thinned and stagnated since 1906. The most notable changes are the transition from a calving, tidewater glacier in open water (bottom left, 1906) to a grounded, debris-covered glacier (bottom right, 2004), and the transition from a 558-foot- (170-m-) deep fjord (left) to a glacial outwash plain that is well above sea level (right).

NPS**FACT**

Named glaciers occur in 18 parks in the National Park System, primarily in Alaska, with more than half of that state's 50,000 or more glaciers located in national parks. In the lower 48 states, glaciers occur in nine park units, with more than 95% of those found at North Cascades National Park (Washington).

Glacier mass peaked at the height of the Little Ice Age, from approximately 1750 to 1850. Since then, Glacier Bay National Park (Alaska) alone has lost more ice than any other place in North America—**approximately 600 cubic miles (2,500 cu km) in about 250 years, an amount that would cover the state 6 feet (1.8 m) deep.** Ecological effects of this tremendous loss of ice include the rapid invasion of plant species to newly exposed land and the transformation of the landscape from a glacier-filled valley to a fjord as ice melts, or from a fjord to a river as the fjord fills with sediments. Additionally, **this ice unloading at Glacier Bay is responsible for the world's fastest rate of vertical land rise**—approximately 11.5 feet (3.5 m) per century. Tectonic plates in the Earth's crust can shift more easily once relieved of the tremendous weight of the ice, potentially triggering earthquakes.

It is extraordinarily difficult to distinguish the normal (background) rate of glacial decay (and growth) over the past 250 years or more from rates over the past century, which might be accelerated and reflect large-scale climate change related to carbon dioxide and other greenhouse gas emissions in the atmosphere, or could simply be related to local or regional climate change.

award-winner

Jock Whitworth recognized for stewardship of beach habitat at Padre Island National Seashore

Protecting natural resources by working with partners, consulting experts, and cooperating with others but taking a stand when necessary is **Jock Whitworth**'s approach to working at any national park. Currently superintendent of Zion National Park, Utah, he was the recipient of the Director's Award for Superintendent of the Year for Natural Resource Stewardship for his work at Padre Island National Seashore, Texas.

One of the biggest challenges at Padre Island is managing marine debris (photo). Prevailing currents bring much of the trash that is dumped into the Gulf of Mexico right to the park's beaches, littering them with tons of plastic bottles, Styrofoam, Freon tanks, bags, and miscellaneous trash. More dangerous are the barrels and bottles of hazardous materials. Mitigating this enormous problem was a challenge for the superintendent. To start, Jock coordinated staff, volunteers, and citizens doing community service to pick up what they could, but hazardous materials required an expert removal team. Jock and his staff were able to get NPS base funding for the park to hire its own hazmat crew to do the job. For large heavy items, such as buoys the size of trucks that had washed ashore, the park partnered with a local conservation group to contract for the removal. However, the effort that will have the longest-lasting effect was the publication of a park report completed during Jock's tenure. This report detailed a study of the debris and a method of identifying its source. Report in hand, Jock met with the offshore oil and gas and fishing industries in an attempt to have them take responsibility for their dumping and start working out methods of retaining the trash and keeping it out of the Gulf of Mexico.

Another challenge at Padre Island is mitigating the threat to natural resources from commercial oil and gas drilling. Companies exploring for and developing natural gas wells at the national seashore must access private and state-owned mineral rights underlying the park. This requires large vehicles to travel all over park land; installation of drilling equipment can mean removing small sections of dunes and other surface features. Fortunately, laws protect park land where mining and drilling occur. To comply with those laws, the park, the NPS Intermountain Region, and the Natural Resource Program Center, under Jock's leadership, developed a system for evaluating drilling proposals and then established a series of mitigating measures that raised the bar for protecting the environment. Working with the park, these companies are not only cooperating but in some cases committing themselves to even higher standards than the park requires. Their activities certainly impact the park, but they are limited to impacts that can and must be mitigated.

The most important nesting beach in the United States for the endangered Kemp's ridley sea turtle is on Padre Island. When Jock came to the national seashore in 1998, he found an internationally recognized Kemp's ridley recovery program led by USGS field station leader Donna Shaver, who was formerly Padre Island National Seashore's sea turtle biologist. However, there was little base funding for the program, with most of the work being funded by grants and donations. As nesting at the park increased, in part because of an international experiment to build up the Kemp's ridley population, Jock initiated reviews of the program, resulting in successful negotiations with the U.S. Geological Survey to return the program and some of the funding to the National Park Service. Though Kemp's ridleys are still critically endangered and face many threats, nesting continues to increase, but in a safer habitat, thanks at least in part to Jock's leadership in protecting Padre Island. ■

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